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MICE AND THE LARCH SAWFLY

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Many years ago Hewett reported that mice dig up and eat the cocooned prepupae of the larch sawfly, but he regarded this activity as being rather abnormal for these animals and appears to have considered his observations as being interesting but of little real significance. The author has long suspected that mice are much more highly insectivorous than they are usually thought to be. This suspicion has been strengthened from time to time when some of his entomological experiments have been destroyed by these rodents. It has been found necessary to use the greatest precaution in protecting experimental insects from mice.

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Many years ago Hewett reported that mice dig up and eat the cocooned prepupae of the larch sawfly, but he regarded this activity as being rather abnormal for these animals and appears to have considered his observations as being interesting but of little real significance. The author has long suspected that mice are much more highly insectivorous than they are usually thought to be. This suspicion has been strengthened from time to time when some of his entomological experiments have been destroyed by these rodents. It has been found necessary to use the greatest precaution in protecting experimental insects from mice.

During the summer of 1927 a mouse found his way into a cage containing larch sawfly cocoons and destroyed the greater part of its contents. A study of the havoc resulting from this foray led to the work on which this paper is based. Examination of this cage after the damage had been done revealed two things. First, that the incisor marks around the opening made by mice in a cocoon served to distinguish cocoons opened by mice from those from which sawflies had emerged normally or those from which parasites had emerged. Regardless of the size of the opening, and some are very small, the incisor marks can be distinguished if a cocoon has been opened by a mouse. The second fact brought out was that a mouse in eating a larva discards all the skin and hard parts and only consumes the soft tissues of the insect. Thus insect food might not be evident in post-mortem stomach examinations.

Examination in the swamps showed that a very large proportion of sawfly cocoons in nature had not emerged normally but had been opened by mice. In a collection made near Itasca Park, out of 481 open cocoons of the larch sawfly 74, or 15 per cent, had emerged normally, 382 cocoons, or 80 per cent, had been opened by mice, 15 cocoons, or 3 per cent, had been parasitized by insects, and 10 cocoons, or 2 per cent, had been destroyed by fungi. Other collections showed a similar condition in many other swamps in and around Itasca Park, Minnesota. Later in the autumn of 1927 similar conditions were observed in Michigan, and since that time observations made in many different localities indicate that wherever the larch sawfly occurs mice are of much value in reducing the abundance of this insect.

During the season of 1928 random collections were made both in Minnesota and in Michigan that demonstrated more conclusively the importance of mice as destroyers of the larch sawfly. The data from these collections are summarized in Table I.

The unopened cocoons, in the Minnesota collections, were placed in cages until the sawflies or parasites had emerged. This was not done with the Michigan collection. Therefore, in order to make the data comparable, the major portion of the cocoons recorded in the living column should be added to those under normal emergence as most of the unopened cocoons would have emerged normally if given the opportunity.

TABLE I

Environmental Resistance as Indicated by Random Collections in 1928

Locality	Number cocoons	Normal emergence		Opened by mice		Parasitized		Killed by fungi		Dead for unknown cause		Living	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Itasca Park, Minn.	796	197	25	516	65	35	4.0	19	2.3	28	3.5	3	0.2
"	404	139	34.3	209	51.6	48	12.0	0	0	9	2.0	1	0.1
"	382	186	48.6	173	45.4	17	4.5	3	0.8	2	0.5	1	0.2
"	911	161	17.6	713	78.1	14	1.6	13	1.5	6	0.7	4	0.5
"	1020	442	43.2	512	50.2	31	3.0	3	0.3	29	2.8	3	0.3
Total	3513	1125	32.0	2123	60.4	143	4.1	38	1.1	74	2.1	12	0.3
Mud Lake, Mich.	2173	452		1354		103		11				254	
	438	48		346		5		3				36	
Total	2611	500	20.8	1700	62.5	108	4.6	14	.51			290	11.6

It is interesting to note from the above table that the percentage of parasitism is very low both in Minnesota and Michigan whereas the percentage of cocoons opened by mice is in the neighborhood of 60 per cent. In making collections all cocoons found were retained. Since the sawfly cocoons do not decompose

for a number of years after they are spun the results of these collections represent averages over a series of years. It seems quite possible that variations in abundance of either mice or sawflies would result in annual fluctuations in the proportion of cocoons opened.

In addition to the random collection of cocoons discussed above cocoons were collected in a uniform manner on sample plots in Mud Lake Swamp. Each sample plot was rectangular and 66 feet on each side, thus making them 1/10 acre in area. Along a line drawn diagonally across each plot ten sub-plots were established at equal intervals. Each sub-plot was one foot square. Each of these plots was carefully examined and all cocoons both old and new were collected and examined carefully. The results of this study are tabulated in Tables II and III.

TABLE II

Environmental Resistance as Indicated by Plot Studies in Mud Lake Swamp, Michigan, Oct. 1927

Plot No.	Number of cocoons	Normal cocoons on sub-plots		Cocoons opened by mice		Parasitized		Killed by fungi	
		No.	%	No.	%	No.	%	No.	%
1	18	9	50	1	6	3	16	5	28
2	79	32	40	39	49	8	11	0	0
3	37	15	40	18	49	2	5	2	5
4	136	28	21	96	70	4	3	8	6
5	119	50	42	59	49	8	7	2	2
6	47	2	4	39	83	6	13	0	0
Total	436	136		252		31		17	
Ave. per sq. ft.	7.3	2.3	31	4.2	57	0.5	7	0.3	4

TABLE III

Environmental Resistance as Indicated by Plot Studies in Mud Lake Swamp, Michigan, Oct. 1928

Plot No.	Number of cocoons	Normal cocoons on sub-plots		Cocoons opened by mice		Parasitized		Killed by fungi	
		No.	%	No.	%	No.	%	No.	%
1a	155	43	27.8	104	67.1	8	5.1	0	0
2a	260	48	18.5	208	80.0	4	1.5	0	0
3a	501	211	42.0	264	52.8	26	5.2	0	0
1b	278	109	39.2	166	59.8	3	1.0	0	0
2b	288	68	23.6	215	74.8	5	1.6	0	0
1c	170	42	24.5	115	67.5	11	6.4	2	1.6
2c	256	54	21.2	191	74.5	9	3.5	2	1.8
Total	1908	575		1263		66		4	
Ave. per sq. ft.	26.5	8.2	30	18.04	66.3	0.94	3.5	0.05	0.2

The results of these systematic collections are very similar to those obtained in the random collections. In fact the results in 1928 are almost identical. This would seem to indicate that either method will give satisfaction if we collect a sufficiently large number of cocoons. The plot method does, however, have at least one distinct advantage over the random method. It shows not only the relative proportion of cocoons opened by mice, parasitized and normal, but also indicates the degree of sawfly concentration at the point where the collections were made.

From the data presented in Tables II and III there appears to be no relation between the relative concentration of the sawfly on the plots and the proportion of cocoons opened by mice. From this it would appear that there is

little or no tendency on the part of the mice to concentrate on those areas where the sawfly cocoons are most abundant. The local distribution of mice, then, must be regulated by some other factors than abundance of sawflies.

In general it appears that mice are most effective in destroying larch sawfly cocoons in places that are not very wet and where the ground is covered with moss or other loose material through which they can dig easily. Under such conditions mice will find an abundance of food and shelter throughout the year and therefore it seems logical to assume that in such locations they will occur in their maximum abundance.

In dense sod or where the ground is excessively wet mice open a much smaller proportion of the sawfly cocoons. Such conditions offer the minimum opportunity for shelter and relatively little food. Therefore we may logically assume that under such conditions the mouse population will of necessity be sparse. It appears then that the proportion of cocoons opened by mice is an indication of the relative concentration of the mouse population.

Measurement of Mouse Abundance in Terms of Cocoons Opened by Them

The measurement of one phenomenon in terms of its effect upon another is an accepted principle in both physics and chemistry. We measure light in terms of its effect upon chemical activity or we measure temperature in terms of its effect upon some substance such as mercury. We have become so familiar with these methods that we think of temperature not in heat units but in terms of its effect on the mercury in our thermometer.

When, however, we attempt to measure biotic phenomena we practically always attempt to measure them in terms of the phenomena themselves. If we wish to measure the abundance of an insect we try to count the insects on a unit area or

volume when we might just as well measure them in terms of their effect upon their food. Likewise if we wish to measure the abundance of mice we feel that it is necessary to count the individuals on unit areas when we might use other easier methods.

The observations of mice and the larch sawfly suggest the possibility of measuring mouse abundance in terms of the effect of these animals on some food material. Such a method would be simple and would in no way interfere with the animals. It could be used in places and under conditions where other methods would be impossible.

The collection of sawfly cocoons and the classification of these cocoons in such a way as to show the proportion opened by mice is apparently one way of measuring mouse abundance. This method, as we have already pointed out, does not show the abundance of these animals from year to year but gives us only the average abundance for a series of years. In order to measure the relative abundance of mice from place to place at any given time it is necessary to use some other method.

With this end in view a series of experiments were started in 1927 and carried through 1928. The results from these experiments are summarized in Table IV.

The purpose of the experiments was to measure the relative abundance of mice on a series of plots used in the study of the larch sawfly in Itasca Park, Minnesota. The method of procedure was as follows: Ten points were established and marked with a stake at regular intervals along a diagonal of each plot. Near each of these stakes was buried a cheese-cloth bag containing several larch sawfly cocoons. In 1927 five cocoons were placed in each bag, whereas in 1928 three were placed in each. Just previous to the closing in of winter and again in the following summer the cocoons planted in 1927 were examined. Those planted in 1928 were examined late in the fall and will again be examined next summer. The number of cocoons found is taken as an index of mouse abundance.

TABLE IV

Effect of Mice on Larch Sawfly Cocoons Planted on Plots

Plot No.	Cocoons[1] planted Aug. 24, 1927										Cocoons[2] planted Aug. 30 and Sept. 1, 1928			
	Examination Nov. 4, 1927				Examination July and Aug. 1928				Examination Oct. 13, 1928			
	Undisturbed		Open or gone		Undisturbed		Open or gone		Undisturbed		Open or gone	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1									10	100	0	0
2	3	30	7	70	1	10	9	90	8	80	2	20
3	5	56	4	44	4	44	5	56	10	100	0	0
4									8	80	2	20
5	3	30	7	70	2	20	8	80	10	100	0	0
6	5	50	5	50	4	40	6	60	10	100	0	0
7	3	30	7	70	2	20	8	80	9	90	1	10
8	7	70	3	30	3	30	7	70	8	80	2	20
9	8	80	2	20	8	80	2	20	7	70	3	30
10									10	100	0	0
11									10	100	0	0
12	4	40	6	60	2	20	8	80	10	100	0	0
13	3	30	7	70	2	20	8	80	8	80	2	20
14					2	25	6	75	10	100	0	0
15	3	33	6	67	0	0	9	100	9	90	1	10
16	3	30	7	70	3	30	7	70	8	80	2	20
17	5	50	5	50	2	20	8	80	10	100	0	0
18					7	77	2	23	10	100	0	0
19									9	90	1	10
20					3	33	6	67	10	100	0	0
21									10	100	0	0
22									10	100	0	0
23									10	100	0	0
Totals	52	44	66	56	45	31	99	69	214	93	16	17

1 - Each unit represents 5 cocoons.

2 - Each unit represents 3 cocoons.

Table IV shows that there is a considerable difference in the proportion of cocoons found by mice on the various plots. Some cocoons were found on every plot in 1927. The proportion was in general correlated with the availability on the plots of food and shelter for mice. On most of the plots mice were apparently doing very effective work in finding and destroying sawfly cocoons.

In 1928, however, a very different condition prevailed. On many plots none of the cocoons were disturbed, while on the others only 20 or 30 per cent of them were found. The reason for this difference was not difficult to find. During the season of 1927 the swamps in Minnesota were relatively dry so that dry nesting places were abundant. In 1928, however, as a result of a wet season, the water in the swamps was high, so that conditions were decidedly less favorable than in the previous summer. As a result the mice were forced to leave the swamp. Possibly many young may have been drowned in the nests. At any rate the effect of the mice on the sawfly cocoons was reduced as conditions became unfavorable for them. With one exception the percentage of cocoons found by mice was lower in 1928 than in 1927. The exception was plot 9. There was little evidence of mouse activity on this plot either in 1927 or 1928. The plot is somewhat higher than the others and was affected very little by the high water. The scarcity of mice on this plot is probably explained by the scarcity of herbaceous vegetation, including moss, on the ground. As a result relatively little cover or food was available during either season.

From this experiment it appears that the relative abundance of mice as a group may be satisfactorily measured in terms of their effect upon some food material. Sawfly cocoons may not be the most desirable material to use, however, Perhaps some grain or wild seed might prove better. The principle, however, appears to be sound.

Conclusions

In the foregoing pages we have shown that one of the important factors of environmental resistance tending to hold down the numbers of the larch sawfly is the effect of mice. These animals open and destroy on the average about 60 per cent of the larvae that succeed in spinning cocoons. Comparable results were obtained by both random collections of cocoons and by more systematic collections made on sample plots.

Cocoons opened by mice may easily be distinguished by the marks of the incisor teeth along the edge of the opening made in the cocoon. In eating a larvae taken from a cocoon a mouse consumes only the soft internal parts, leaving the skin and hard parts. Therefore this type of food would not be evident in the stomach examinations.

The degree of effectiveness of mice in destroying sawfly cocoons appears to be a reliable measure of mouse abundance on an area. It is suggested that instead of the slow and difficult trapping methods of estimating mouse abundance that the abundance of these animals be measured in terms of their effect upon some standard food presented to them in a standard manner.